BULLETIN 444 NOVEMBER, 1929

# The Strawberry in Ohio

J. S. Shoemaker

OHIO
AGRICULTURAL EXPERIMENT STATION
Wooster, Ohio

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# THE STRAWBERRY IN OHIO

J. S. SHOEMAKER

## INTRODUCTION

The value of strawberries harvested annually from plantations in Ohio is roughly estimated at a million dollars. In 1928, for example, the commercial acreage was 3,700 acres, the production 5,920,000 quarts, and the value $1,066,000. To this might be added undetermined acreages, particularly home plantings.

Commercial plantings are mostly smaller than five acres; a few are as large as ten acres or more. They are distributed thruout the State with some concentrated plantings near the large cities.

**TABLE 1.—Acreage, Production, Yields, Prices, and Carlot Shipments of Strawberries in Ohio. From Thomsen and Thorne (23)**

| Year | 1918 | 1919 | 1920 | 1921 | 1922 | 1923 | 1924 | 1925 | 1926 | 1927 |
|---|---|---|---|---|---|---|---|---|---|---|
| Commercial acreage, acres..... | 2,660 | 2,800 | 2,810 | 2,890 | 2,740 | 2,800 | 3,800 | 3,700 | 3,600 | 3,780 |
| Production, thousand quarts... | 4,150 | 5,040 | 4,923 | 4,994 | 4,472 | 5,600 | 7,600 | 3,330 | 9,000 | 5,795 |
| Yields per acre, quarts..... | 1,560 | 1,800 | 1,752 | 1,728 | 1,632 | 2,000 | 2,000 | 900 | 2,500 | 1,533 |
| Prices per quart, cents..... | 14 | 17 | 18 | 25 | 10 | 15 | 13 | 24 | 16 | 16 |
| Carlot shipments number..... | ..... | ..... | ..... | 19 | 25 | 8 | 11 | ..... | ..... | 2 |

The average yield of strawberries in Ohio for 1918 to 1927, inclusive, according to Thomsen and Thorne (23)[1], was 1,741 quarts per acre. This is far below the possible yield. With a good site, proper culture, and good suitable varieties, yields of 3,200 quarts up to 7,000 quarts per acre may be secured in favorable seasons.

Certainly many strawberry growers in Ohio, without increasing their acreage, could more than double their present yield by judicious selection of varieties and better culture.

It is the purpose of this bulletin to consider strawberry culture in general and to present experimental results. The facts that the strawberry is so widely grown and that it is fairly productive under many conditions and practices indicate that this fruit is easy to grow. Yet it is often greatly mistreated in culture.

[1]Numbers in parentheses refer to literature cited, page 50.

## LOCATION AND SITE

Among important factors influencing the success of a strawberry plantation are nearness to market, good site, proper soil, and adequate labor supply. Any one factor is frequently offset by another. For example, a certain district may be ideally located from a fresh fruit market standpoint. Another district may be relatively distant from such a market, but have compensating advantages in lower-priced land and cheaper labor. Trucking strawberries fifty miles or more is often practiced.

Such a factor as availability of straw for mulching might not seem to be of much importance, yet in some sections the difficulty of obtaining straw and its relatively high cost are serious drawbacks to profitable strawberry growing.

**Fig. 1.—Matted row, straw mulched plantation brought thru the winter in good condition**

It is usually better not to undertake a large acreage until experience has been gained from smaller plantings. Profits do not always increase in proportion to increased acreage. With regard to carlot shipments, Colby (3) estimated that if it is desired to load a car daily during the shipping season, a minimum area of 100 acres conveniently located about the shipping point is necessary.

**Soil.**—Strawberries are grown successfully on a diversity of soil types. Avoid decidedly heavy and extremely light soils. Soils that are hard to work, bake readily, and absorb water slowly are undesirable. Light soils are easily worked, may be prepared for

planting early in the spring, tend toward production of early berries, and are most suitable for making new plants. Clay soils, are usually somewhat high in humus content, retentive of moisture, and naturally fertile, but often poorly drained. Probably the best soil is a fertile sandy or gravelly loam that is retentive of moisture and easily tilled.

**Water drainage.**—Good water drainage is essential in a strawberry plantation. Water standing even for a few hours at any time of the year will cause damage. Ball and Mann (1) found that the effect of water-logging is to reduce the root system, the old roots being killed and the new ones failing to develop to their full extent. Colby (3) mentioned that poor water drainage is probably responsible in part for the "Black root" disease of strawberries of which growers have complained during the last few years. The site should possess sufficient slope and be free from pockets or basins so that surface drainage will take care of the surplus water, particularly during late winter and early spring when the snow is melting and at other times when tile drainage does not function adequately.

Tile poorly drained land and, if the soil is still wet, provide surface drainage by leaving dead furrows at frequent intervals.

Moisture requirement of the strawberry is associated with the fact that the root system is shallow and not extensive.

Ball and Mann (1) found that 90 percent of the total root system, based on dry weight determinations and expressed as percentages of the total dry weight of the root system, was present in the uppermost six inches of the soil.

Weaver and Bruner (26) described the root habits of the strawberry. The fibrous root system arose from the short, thick stems near the soil surface. Just underneath the surface, horizontal roots extended about a foot on all sides of the base of the plant. This delimited the lateral spread. The surface foot of the soil was fully ramified by obliquely descending roots as well as many more or less vertically descending ones. The latter, especially, also ramified the second and some of them the third foot of soil. Branches were mostly short but abundant, usually being more profuse in the surface 12 inches.

White (27) studied the physiological anatomy of the strawberry. In the crown the entire vascular cylinder was made up of a network of short anastomosing bundles which provided an efficient means of rapid transfer of water and solutes across the stem. Moreover, these bundles themselves, instead of being made up of long vessels, were composed of short tracheids provided with numerous large, lateral and terminal pores which further increased the efficiency of cross as well as longitudinal transfer of water. Such a crown structure made it possible for plants that had most of their roots cut by a hoe or insect, or destroyed by fungi, to supply all leaves, runners, and other parts

uniformly with water and nutrients. Broadly speaking, moisture and nutrients supplied to one side of a row of plants could be assumed to supply both sides of the plant uniformly, in striking contrast to most woody plants. Reduction of any part of the root system affected the plant as a whole rather than one side alone. Marked differences in the arrangement, development, and structure of the vascular tissues of the large adventive roots that arose from the crown, as compared with the small fibrous ones, together with the paucity of root hairs accounted for their comparative inefficiency as absorbing organs. This apparently explained the difficulty in transplanting plants possessing many large roots but no fibrous ones as compared with those having at least a few small roots.

Since the roots of the strawberry spread out close to the surface and do not penetrate very deeply, the soil should be rich in organic matter in order to absorb and retain moisture.

**Soil reaction.**—There is evidence in the horticultural literature and practical experience that liming strawberry fields has seemed to prove harmful. On the other hand, there is also evidence indicating somewhat beneficial results from moderate liming of soils and that the strawberry is fairly tolerant to various soil reactions.

Morris and Crist (19) summarized their studies on the influence of culture medium on growth of strawberry plants, in part, as follows: (a) Both wild and cultivated strawberry plants were found growing vigorously on acid, neutral, and alkaline soils. In most instances, however, the soils were somewhat acid in reaction. (b) In water cultures, strawberry plants survived within the pH range of 4 to 8. Growth was very satisfactory within the range of 5 to 7. The optimum reaction was 5.7 to 6[2]. (c) The reactions commonly found in so-called "agricultural soils" are probably *per se* not important limiting factors in strawberry production.

**Site and air drainage.**—Injury from late spring frosts can be prevented to a certain extent by choosing a site with good air drainage, which, according to Colby (3), requires a slope of about 3 feet in 100. Early ripening is encouraged by a southern and late ripening by a northern exposure or well drained bottom land. During the fruiting season a northern or northeastern exposure affords some protection against hot, dry winds of summer.

Because of the strawberry's habit of growing close to the surface of the ground where the coldest air settles, especially on clear, cold, calm nights in early spring, the blossoms are unusually subject to injury by late spring frosts. Unmulched plants, plants on a southern exposure, and early blooming varieties are often the most susceptible. Mulched plants, on the other hand, bloom later and

[2]Figures less than pH 7 denote acid reaction.

have more protection for their blossoms. Injury from late spring frosts can be avoided to some extent by the time of removing the mulch, and by planting on a site with good air drainage.

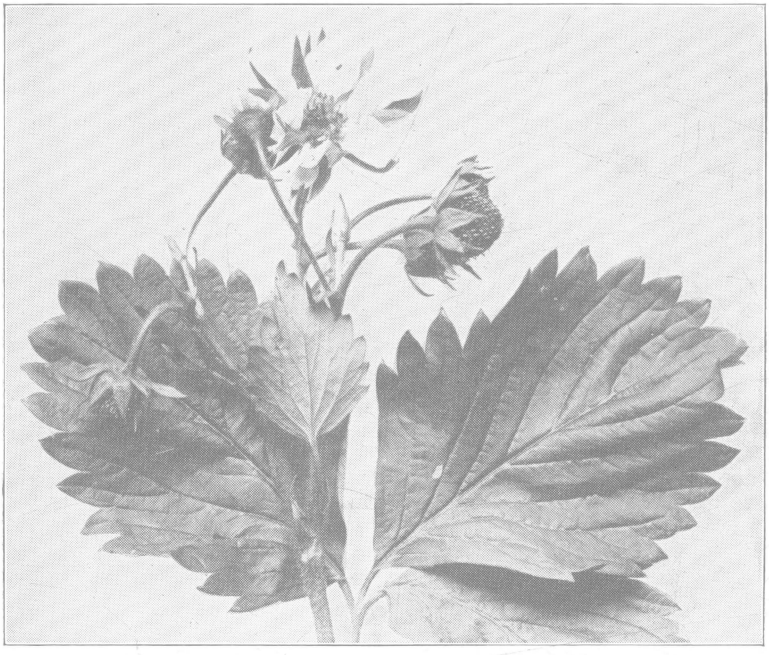

**Fig. 2.—Frost injury decreases both quantity and quality of fruit**

Where heating to avoid frost injury is considered, it should be borne in mind that there is danger of fire because of the mulch in the plantation. The fact that the blossoms of the strawberry do not all appear at once is a factor in relation to injury from frosts. Windbreaks are sometimes used but are of doubtful value. Chandler (2) remarked that in a level area, or one nearly level, a windbreak, by lifting what little wind there is, may cause a frost pocket behind it. He stated further that it is not uncommon to see fruit blossoms, particularly strawberry blossoms, killed in the still air behind a windbreak when in the remainder of the field they are uninjured.

Steep slopes are likely to wash badly and cannot be worked as advantageously as land that is nearly level. When strawberries are planted on hillsides the rows should follow the contour of the land.

**Inter-crop.**—The advantages of strawberries as an inter-crop in an orchard are many. They furnish a source of income while the orchard is being established. They bear the year after planting and give a dependable cash return. Strawberries may be rotated from one location to another in the orchard thus affording an opportunity for cultivation, or for building up and maintaining fertility and humus content by a system of plowing under green manure crops. The disadvantages are that mice are sometimes harbored under the mulch of strawberries and may attack the trees; that fire is a hazard when straw is placed in an orchard; that orchard operations are made more difficult; and that the planting may retard the growth of the trees.

Fig. 3.—Strawberries are a fairly good intercrop in a young orchard

## ROTATIONS

Sod land is not desirable for strawberries, unless it is cropped for a year or more previous to setting. Sod is often infested with white grubs and other injurious insects that may damage plants and cause a poor stand.

Do not grow strawberries continuously on the same soil. Some of the chief purposes of cropping systems are to grow one or more leguminous or green manure crops in a rotation to build up humus

content and to precede strawberries with cultivated crops so as to reduce certain insect and disease troubles, weeds and grass, and unsatisfactory physical condition of the soil.

The best rotation to practice will depend to some extent on the previous treatment of the soil, the adaptability of the crop to the soil, the acreage involved, utilization of the crops in the rotation, ease of incorporating the vegetative growth with the soil, limitations of the growing season, and various other factors. Sometimes a crop occupies the land over winter and is turned under in early spring, or the soil may be plowed in the fall and left in the rough until spring. In general, the length of time that other crops occupy the land in a rotation should at least equal that of strawberries. Where a grower has plenty of land longer intervals between strawberry plantings are desirable.

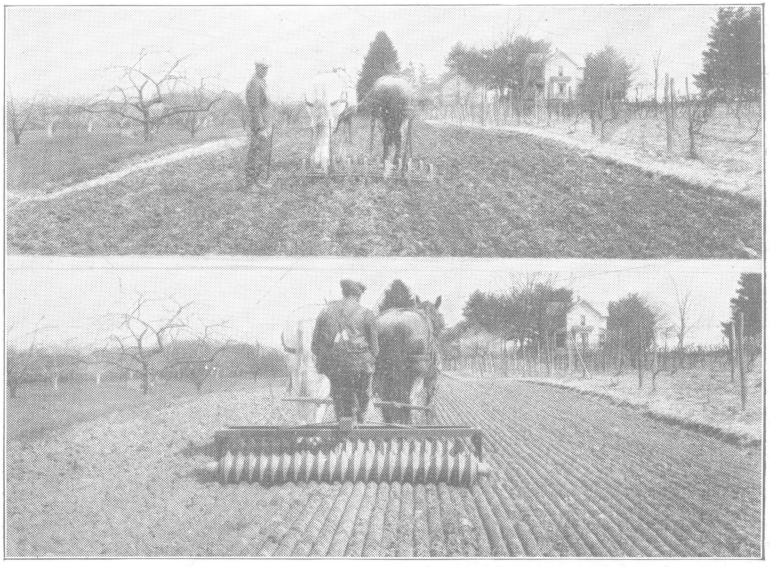

**Fig. 4.—Thoro preparation of soil and careful handling of plants resulted in loss of only 1 plant of 1500 set in this plantation**

Clover, two years, is popular with strawberry growers who follow a definite rotation. The clover is followed by a cultivated crop, such as potatoes, corn, or tomatoes. Cultivated crops harvested by the middle of August may be followed by an overwintering crop, turned under very early in the spring. When corn precedes strawberries, a cover crop may be seeded between the rows at the last cultivation. Sometimes a small grain crop is

grown between the clover and the cultivated crop. Garden vegetables for two years, with liberal applications of manure, make a fairly good short rotation with strawberries.

## PREPARATION OF SOIL

A well pulverized, mellow soil is conducive to a good stand of plants, for they not only survive planting but become established quickly.

Begin treatment of the soil for strawberries at least the previous year, preferably earlier. Factors of humus and cultivation are involved. The practice of plowing in the fall, and working the soil down early in the spring to make it friable, smooth, and ready for early planting, is encouraged.

## PLANTING

### SYSTEMS OF TRAINING AND PLANTING DISTANCES

There are two main systems of training strawberry plants, matted rows and hills.

**Matted row system.**—Most commercial plantations in the State are grown under the matted-row system. Runners are permitted to set in all directions. Cultivation tends to straighten the runners into the rows and to limit the width of the row.

Probably the most common planting distance and that generally recommended is 3½ feet between the rows and 1½ feet apart in the rows; but this spacing can often be modified to advantage. Some growers prefer 4 feet between the rows, few exceed this distance. Rows closer than 3 feet are seldom advisable for commercial plantations. Instead of planting 1½ feet apart in the rows the distance may be increased to 2 or 2½ feet on good soils with varieties that are prolific plant makers, or where cross-cultivation is a major consideration, and reduced to 15 inches on rather poor soils with varieties that are indifferent plant makers.

The number of plants required to set an acre is obtained by multiplying the distance between rows by the distance apart in the row, in feet, and dividing the product into 43,560, the number of square feet in an acre. For a smaller area the same procedure is followed except that instead of dividing into 43,560 divide into the number of square feet contained in the area to be planted.

The most desirable width of row is influenced by such factors as variety, soil, and method of cultivation. Under most conditions a fruiting matted row of 15- to 20-inch width is preferable to a

wider or narrower one. With equal planting distances, the wider the matted row, the greater the production of berries. On the other hand, narrow to medium matted rows originally set 3½ feet apart are likely to result in a more satisfactory product and are easier to pick than those set farther apart and permitted to become too wide.

**TABLE 2.—Number of Plants Required per Acre With Various Distances of Planting**

| Distance apart in row | Distance between rows | | |
|---|---|---|---|
| | 3 feet | 3½ feet | 4 feet |
| *Inches* | *No.* | *No.* | *No.* |
| 12 | 14,520 | 12,446 | 10,890 |
| 15 | 11,616 | 9,956 | 8,712 |
| 18 | 9,680 | 8,297 | 7,260 |
| 24 | 7,260 | 6,222 | 5,445 |
| 30 | 5,808 | 4,978 | 4,356 |
| 36 | 4,840 | 4,150 | 3,630 |

As a general rule, best results are obtained when the plants finally stand 6 inches apart in the matted rows. With varieties and under conditions that produce dense foliage, spacing 8 inches apart may be preferable. On the other hand, varieties like Senator Dunlap commonly make small plants; spacing 4 inches apart may be the best distance.

Chandler (2) stated that runners seem to inhibit crown formation on the original plant even after there has been rooting at the nodes. In other words, the inhibiting influence of a growing runner seemed to be transmitted thru one or even several rooted nodal plants, crown formation at these nodes being also inhibited. Generally only a small number of crowns formed on any plants unless the runners were cut. In fact, even when a wide matted row was used it seemed wise to cut the runners, after the row became fairly thick, and thus encourage the formation of extra crowns on the plants that had rooted.

Few growers make a special practice of thinning or spacing plants in matted rows. In many cases it might be advantageous to do so. Thinning is usually done in the fall with a hoe.

Try to secure a full stand in the matted row by early September. It is seemingly a mistake to cut off early formed runners; as these are much more productive than late formed ones, Table 5. With varieties like Premier the necessity for thinning late runners may not be as imperative as with more prolific plant makers. If the plants are set late, it may be advisable to encourage rooting of late runners to secure a full stand in the matted row. Experiments of Davis (6) and of Ruef and Richey (21) indicated some of the drawbacks of late runners.

Davis showed with Parsons Beauty (a) that the stolons formed in the early part of the season gave the largest numer of flower stalks and hence the largest yield of fruit; (b) that, altho the stolons produced directly by the original parent were not in all cases the earliest formed or rooted, they gave larger returns than other stolons, or, in other words, that there was also correlation between yield and generation. The practical value of this is that early planting and extra care during the early part of the season are of the utmost value in economic strawberry production. Davis said that two plantations having in November an apparently equal stand of plants may give enormously different results in yield the following year if one has a large stand of early rooted plants and the other a stand composed largely of late formed stolons. If a practically full stand can be obtained by the first of September, or the middle of September, it would be better from that date to keep the late formed plants cut off, in order to give the earlier formed ones every opportunity of developing crowns for the succeeding year. Late planting should be avoided, where possible, as it is almost certain to result in low yields of fruit.

Studies of Ruef and Richey indicated that the earlier the date of fruit bud differentiation and the more fully developed the flower stalk, the greater the plant's resistance to winter injury.

**TABLE 3.—Winter Injury. From Ruef and Richey (21)**

| Position of plant on runner | Plants winter killed | |
|---|---|---|
| | *No.* | *Pct.* |
| First | 0 | 0 |
| Second | 2 | 4 |
| Third | 15 | 30 |
| Fourth | 45 | 90 |
| Fifth | 49 | 98 |

**Modifications of the matted row.**—Hedgerows are modifications of the matted row system. Hedgerows are better adapted to small areas than to commercial plantations, and for varieties that make relatively few runners than for those that are free running. Hedgerow training requires a great deal of careful work and entails definite placing of a certain number of runners from each plant, after which all later runners are removed. In the single hedgerow system the plants are set 15 to 18 inches apart in rows 24 to 30 inches apart. Usually two runners are permitted to root and these are bedded in line with the parent plants. Another hedgerow system is to bed a total of four to eight runners from each plant, nearly equal distances apart, but restricted from extending too far between the rows.

**Hill system.**—In the hill system all runners are removed as they appear and the original plants encouraged to stool out in large crowns. Plants are spaced 12 to 30 inches apart in rows 2½ to 4 feet apart.

**Matted row vs. hill system.**—Many tests have shown that June bearing varieties in Ohio are more productive in matted rows than in hills. Plants in this State, except under very favorable weather conditions, seldom develop the large size necessary for successful hill culture as practiced in certain sections of the country where the climate, varieties, and other factors are suitable.

Plantings grown according to the hill system often are damaged more by heaving out and other adverse weather conditions than those in matted rows; that is, when a plant in the hill system dies a relatively large gap is left.

Claims sometimes are advanced that the hill system encourages production of uniformly large berries. Possibly, berries grown in hills may not always decrease in size to the same extent as those in matted rows, but it is usual for fruit uninjured by frost or otherwise to become progressively smaller as picked from primary, secondary, tertiary, etc., positions on the cluster. Attempts sometimes made to fruit hill plantations longer than matted rows, result in small berries.

Plants in the hill system are easy to weed, as cultivation both ways is practical thruout the first season. A few cross-cultivations may be given plants in matted rows when set 2 feet or more in the row, or when a small horse or mule is available for working rows with plants 1½ feet apart. Cross-cultivation of matted rows must be narrowed down and finally discontinued as the runners fill the rows; but cultivation between the rows can usually be practiced thruout the season.

It is sometimes said that the hill system of planting makes picking easier and the fruit cleaner, particularly in comparison with wide matted rows. Perhaps, the fact that the hill system yields less fruit than the matted row is one reason why the hills are easier to pick; but the difference in growth under the two systems is of course fundamentally involved and in general favors the hill system for convenience in picking. Mulching with straw has some tendency to equalize the ease of picking and weeding and the cleanness of fruit grown under the two systems.

A larger number of plants is usually required to set a given area to the hill system than to the matted row system. Cutting off the runners as they appear is a costly item of expense.

### TIME OF PLANTING

The best time to set strawberry plants in Ohio is in early spring; just as soon as the soil can be well prepared. Plowing in the fall tends to hasten drying of the soil in early spring and thus promotes early planting. Plants set early in April at Wooster nearly always do better than plants set a month or so later. In many years there is two weeks or so of relatively cool, damp weather in late spring when planting may be done if previously neglected. It is difficult to secure a good stand with plants set after the May rains. Setting plants in dry, hot weather is a poor method of starting a strawberry plantation. Benefits from early spring planting are associated in part with the moisture supply, with the fact that the strawberry is naturally a lover of moderate to cool temperature, and with the development of most productive runners.

Summer or fall planting of strawberries in Ohio is not recommended. Ordinarily there is one year, usually the first fruiting year, in the life of a spring set plantation that may be regarded as a "peak" year. When set in late summer, however, each plant that lives may fruit the following year but the yield will be light. Few productive runners will have been formed. If set in mid-summer, so as to give the plants time to become established before winter, weather conditions are likely to be such that a poor stand is obtained.

For summer planting potted plants (page 43) may be used, but this is an expensive process for commercial culture.

When the object of fall planting is not to hasten fruiting, but to encourage an early start in the spring, or to avoid rush of spring work, extra cultural care is necessary in over-wintering the plants and in controlling weeds. In favor of fall planting it may be said that the plants make growth early in the spring which encourages early formation and rooting of runners, the benefits of which are discussed elsewhere in the bulletin.

### MATING VARIETIES

Certain varieties of strawberries are imperfect or pistillate and require mating or cross-pollination in order to develop fruit. In the flowers of such varieties the stamens are lacking or abortive. Varieties that do not require cross-pollination or mating are called perfect, staminate, or bisexual.

Perfect varieties planted alone mature a crop of fruit. Interplant imperfect varieties with perfect ones, a row of a perfect variety to every three or four rows of an imperfect sort. This proportion is a good guide to follow, altho satisfactory yields have been obtained from a row of perfect to five or six rows of imperfect varieties. The closer the two types are interplanted the less the proportion of deformed berries. The strawberry flower contains many pistils and if a considerable percentage are sterile or not satisfactorily pollinated an irregular, nubby berry is likely to be produced. It should be borne in mind that some perfect varieties are more effective as pollinizers than others and that adverse weather and other environmental conditions are detrimental to adequate cross-pollination.

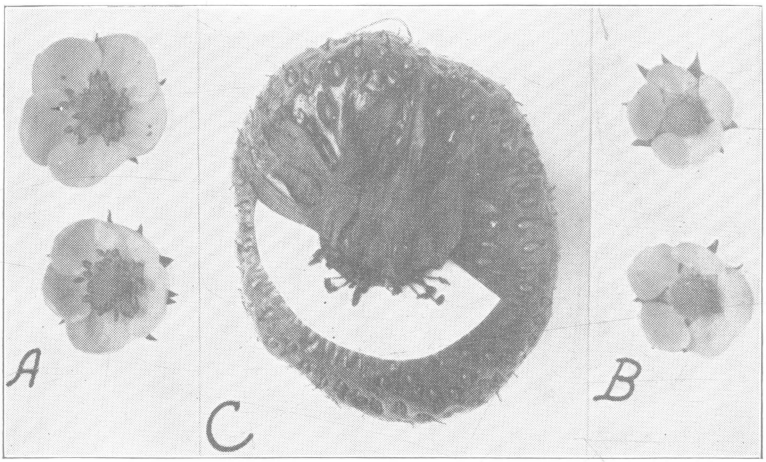


**Fig. 5.—(A) perfect and (B) imperfect blossoms. Perfect and imperfect varieties can be distinguished by fruits as well as by blossoms. Stamens are apparent in abundance underneath the sepals or "hull" of perfect varieties (C), but are rudimentary or few with imperfect varieties.**

Hooper (12) believed that the strawberry can set fruit well almost without insects, and that wind carried pollen over the flower. On the other hand, it has seemed to be the experience of many growers that bees and other insects are important agencies in pollination and that their scarcity or inactivity during bloom is an appreciable drawback.

Valleau (25) found a correlation between flower position and fertility of pistils, fertility decreasing in the later flowers. Pistil sterility is expressed in the production of irregularly shaped berries or entirely sterile flowers.

Gardner (9) determined that size of berry was closely correlated with number of pistils per flower and in the setting of these pistils, that there is progressive decrease in number of pistils per flower from the earliest to the latest flowers to open, and that early removal of primary, secondary, and tertiary flowers leads to setting of later blossoms than otherwise but resultant berries are small and yield correspondingly reduced because of the smaller number of pistils per flower.

Some varieties produce sufficient pollen to fertilize most of their own flowers, but their use as pollinizers for imperfect varieties is questionable. Sometimes, as with Glen Mary, the early blossoms hardly produce enough pollen for themselves, and require cross-pollination for best results. Premier furnishes enough pollen to set fruit by itself, but is not regarded as a good pollinizer for imperfect varieties. When poor pollinizers and imperfect varieties are set out together it is sometimes necessary for best results that the rows alternate. Senator Dunlap gives good results as a pollinizer; most other varieties that produce plenty of pollen are also suitable for this purpose.

### HEELING-IN

Heeling-in is a valuable practice for holding plants a reasonable length of time, but is at best only a makeshift substitute for planting directly. Heel-in plants where water does not collect, yet where they can be watered when necessary. Partial shade, such as furnished by a building, is desirable.

Separate the bunches and place the plants in a trench, with the roots covered firmly with moist soil. Closely arrange the plants in a single row in such manner that the roots of each plant are in direct contact with the soil. Bunched or loosely heeled-in plants are likely to dry out and die. Separate and label varieties.

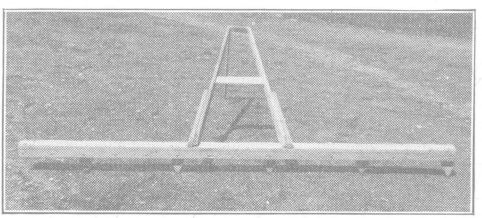

**Fig. 6.—An easily made and handy type of soil marker**

### MARKING THE SOIL

Straight rows give the plantation a neat appearance and are advantageous in cultivation and other operations. There are various methods of marking rows the desired distance apart. The type of marker shown in Figure 6 is commonly used. In large plantations horse-drawn markers are often used. Sometimes a shallow furrow is made with a light plow. Long rows are preferable to short ones.

### SETTING THE PLANTS

For best results in setting, the plants must be in good condition, not dried out nor heated in shipping or handling; the soil must be well prepared and adequately supplied with moisture; the crown must not be placed too shallow nor too deep with respect to the surface of the soil; the soil must be packed firmly against the roots; and the roots must not be bunched too much in the soil.

**Fig. 7.—Before and after trimming for planting**

Good plants for spring setting are thrifty and of the previous season's growth, have a well developed root system of fibrous, light colored roots, few leaves, a relatively slender neck, and are free from injurious diseases or insects. Old plants are not satisfactory. They may be recognized by the presence of dark brown

roots and a thick neck. So-called "pedigreed" plants are not superior to other stock that is well-grown and in healthy condition.

At planting, the roots frequently are cut back to 3 or 4 inches in length, or about one-third of their growth. This root pruning seems to be of uncertain value, altho it is sometimes convenient in planting. Under some conditions it permits better spreading of the roots, and may serve in part to prevent drying out.

Ball and Mann (1) found that trimming the roots ⅛ to ½ before planting did not impair or enhance their ultimate vigor. The treatment resulted in the copious production of lateral roots near the cut ends of the main runner roots, and 6 weeks after planting the bulk of the roots was the same as that of a "normal" plant and hence the growth of the new roots had been greater. They stated that root trimming may possibly be advantageous where the runner roots are abnormally long in which case it would prevent bunching up the roots in the course of planting.

The plants, particularly the roots, must be protected against drying out in the process of transplanting. Avoid exposure to wind or sun. A good method is to take the plants to the field in baskets lined with damp moss and covered with wet burlap or other material. Another method is to immerse the roots in pails partially filled with water. It is important not to drop more than a few plants ahead of the planters, especially under dry weather conditions.

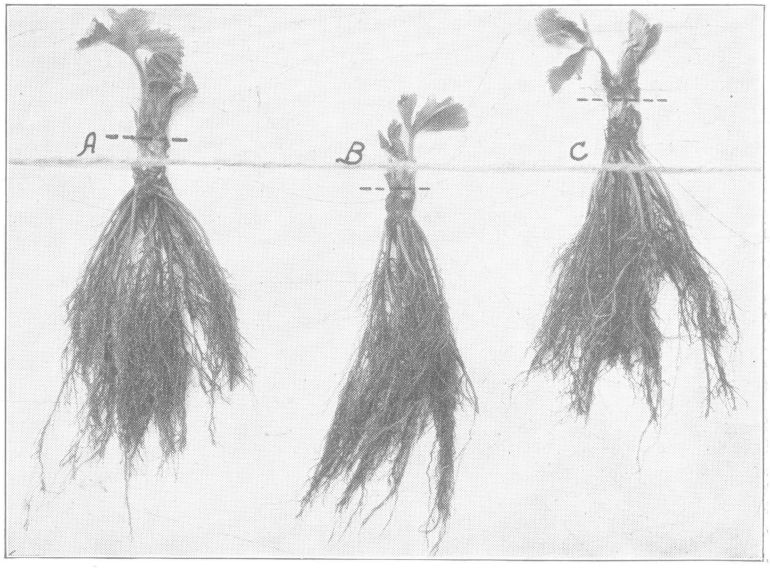


**Fig. 8.—Too shallow (A and C) and too deep (B) planting; the broken lines indicate desirable depth**

Set the plants firmly at the same depth as they previously grew. When the crown is set too high, or the soil is not adequately firmed, the plants are likely to dry out. When the crown is set too low the plant may rot. As the plant develops there is tendency for the short stem to become more and more above the soil.

Ball and Mann (1) studied the effects of depth of planting. In the normal series the soil level was about midway up the crown. With deep planting, the runners were set deep enough just to cover the crown completely with soil. With shallow planting, the runners were planted so that the whole crown was above soil level. Thus the two extremes were taken in order to make the distinction between them and the normal depth of planting quite clear. The effect of the deep planting was to cause a certain amount of root death, but the ultimate vigor of the plants was not much impaired under this condition. The increase in length of the main crown as compared with that of plants set at the normal depth was very noticeable. The effect of shallow planting was more detrimental, resulting in the death of some of the new "primary" roots that were unable to reach the moist soil before succumbing to drouth. The vigor of the plant obtained in the following season was also impaired.

**Fig. 9.—Planting by spade method (left). Removing flower stalks (right)**

The spade method of planting is probably most used. The man using the spade first clears away dry surface soil at the spot where the plant is to be set so that only moist soil comes in contact with the plant. This is done by dragging the spade over about a foot of soil for each plant, just before it is set. Two persons usually work together. One makes a V-shaped opening, by shoving the spade into the ground vertically, and pushing the top back and forth. The other worker then places a plant in position and holds it in place while the spade is withdrawn and used to press the soil against the roots. Avoid too much backward and forward movement of the spade and take care that no air space is left

around the roots. The workers then stand erect and firm the soil on both sides of the plant by foot. If a plant can be pulled out by a quick upward pull of a leaf stem it is not set firmly enough; the leaf stem should break.

When one works alone, a trowel or strong plant dibble is preferable to a spade.

The spade method is preferable to planting in a furrow. Some growers claim that the furrow method is quicker and cheaper than the spade method, while others claim that the furrow method is in fact slower, more expensive, and less reliable. The greater soil disturbance with the furrow method may lead to more drying out of the soil and less firmly set plants than the spade and trowel methods.

Large growers sometimes use a horse-drawn transplanter. This is a quick method, is sometimes indispensable for large areas, reduces the cost of planting, and provides facilities for watering the plants as they are set. Three good workers, with a transplanter, can set about 25,000 plants or 3 or 4 acres in a day. In the operation of the machine, one person drives the team and two others are seated at the rear close to the ground. These two "droppers" place the plants in a trench made by the machine. In order that the "droppers" may work rapidly the plants must be carefully prepared. The plants should be relatively uniform in size, have all dead and superfluous leaves and runners removed beforehand, and have the roots straightened out and arranged in one direction in the containers. Someone should follow the machine to tramp the soil about the roots, to straighten misplaced plants, and to fill in gaps. With careful and experienced workers the transplanter gives good results. It is rather difficult with a machine to set the plants at the proper depth and to spread the roots as satisfactorily as when placed by hand. Few strawberry growers in Ohio use a transplanter as the new acreage set each year is too small in most cases to justify the expense of a machine.

## REMOVING THE FLOWER STALKS

To insure strong fruitful plants when the proper time comes it is advisable that all blossoms, flower stems, and berries be pinched off newly set plants. Removing the flower stalks helps the plants to become firmly established by preventing severe drain on their vitality caused by untimely production of fruit, aids in overcoming drouth conditions, and increases plant formation. Studies of Mann

and Ball (18) indicated that the effect of deblossoming was to increase the general vigor of the plant in both root and shoot and to reduce damage by summer drouth.

For varieties like Premier, the more frequently the plantation is gone over the first year to remove flower stalks the better for the plants. Varieties that, like Senator Dunlap, have an excessive plant forming habit may not require much attention to the removal of blossoms after the plants become firmly established in the soil. For such varieties pinching off the flower stems once may suffice.

Remove blossoms of everbearing varieties for 60 to 80 days from planting, then allow them to form and develop into fruit. It takes about a month from blossom to ripe berry.

## TILLAGE

Cultivation soon after the plants are set and repeated at frequent intervals controls weeds and grass, improves the physical condition of the soil, prevents the surface of the soil from becoming crusted, conserves moisture, and makes plant food more available. Because of its low habit of growth the strawberry is not able to compete as successfully as other fruits with weeds, which deprive the plants of moisture, sunshine, and food.

Loree (14) emphasized the necessity of an abundance of moisture during the few weeks between the time of blossoming and the ripening of the fruit by pointing out that an acre of strawberry plants producing 4,000 quarts of fruit removed from the soil nearly three tons of water in the berries alone. In addition, many times this amount was lost by transpiration from the plants and by evaporation from the soil.

Cultivate increasingly shallow as the season progresses and farther from the original plants each time until the rows are of the desired width. In successive cultivations, always work the same rows in the same direction to avoid disturbing plants already trailed into position by the cultivator. A mellow soil encourages the rooting of runners.

Hand hoeing is likely to be necessary to keep weeds out of the row. At the first hoeing it is important to uncover the buds of too deeply set plants. Such plants when neglected are unlikely to be thrifty, even tho they live thruout the season. Flower stalks can also be removed at this time, altho a separate practice of this work is usually the best plan. At later hoeings, train runners to vacant places, remove those that extend far between the rows, and thin crowded plants.

After the first year, cultivation is delayed until after the fruit is picked, especially when a mulch is left between the rows. A good mulch is an effective substitute for cultivation in fruiting years. If there are indications early in the season that mulched beds are likely to be very weedy it may be a good plan to remove most of the mulch material and then cultivate, but such cultivation tends to make the fruit dirty and is therefore objectionable.

Opening furrows is of some benefit at times in avoiding injury from standing water. Even on land that is tiled or that possesses an open subsoil, winter thaws lead to water collecting in low places and subsequently forming ice and damaging the plants.

## FRUIT-BUD FORMATION

Knowledge of the time of fruit-bud formation in the strawberry is of particular value in relation to time of application of fertilizer. Relatively few growers in the State apply nitrogen fertilizers to strawberries in early fall, altho it seems advantageous to do so.

Ruef and Richey (21) found that the initial differentiation of the first bud of the Dunlap strawberry on the first runner took place in early September at Ames, Iowa. The time of differentiation of the various buds on a fruit stalk depended on their relative positions on the stalk, the development being progressive from the primary to the secondary, tertiary, etc. The time of bud differentiation in the individual plants of a runner differed according to the relative position in age and the time of formation of the plants in relation to the mother plant and to one another. The period of differentiation was not confined to a short time centering around any specific date, but, on the contrary, fruit bud differentiation took place continuously from the beginning of September to the middle of December, after which no further collections were taken from the field. Differentiation might continue uninterrupted until blossoming time in those localities where climatic conditions permit.

There was found to be a difference in the degree of development in the different fruit stalks of the various plants on a runner. Differentiation of the flower buds on the first plant to form occurred about a week earlier than on the second plant. As time advanced a greater interval elapsed before the differentiation of the primary flower on the next plant of the runner. This seemed to indicate that the differentiation and development of the strawberry flower bud is influenced by an internal nutritive condition attained earliest in the older plants of a runner that formed at a time of the year more favorable for plant metabolism. Plants that first reached the stage in their development when utilization of products for further growth was less than production of such products, had an accumulation of such products and were the first to differentiate flower buds.

Richey and Schiletter (20) observed that neither age, position of plant in the runner series, nor leaf area alone determined the time of flower bud formation in the Dunlap strawberry. Lack of moisture and low temperature

hastened flower bud formation. Flower buds were first noticed after the soil had become a little dry and vegetative growth had been slowed up slightly. In one season, after such conditions prevailed, heavy rains fell while the temperature was still high. Vegetative growth, as indicated by runner formation, was increased, and the rate of flower bud formation and development was lessened. A decided drop in temperature late in the fall was followed each year with a marked checking of vegetative growth and increased flower bud formation and development, even tho the soil was well supplied with moisture. Apparently, drouth and cold weather caused a checking in rate of vegetative activity, accompanied by rapid increase in formation and development of flowers.

Davis (7) concluded that strawberry plants formed their fruit buds for the next year's crop at an age of 3 weeks. To affect fruit-bud formation nutritional conditions within the plant had to be altered at about that time, which meant, for the majority of plants, some time in September, at Ottawa, Canada.

Hill and Davis (11) observed first sign of flower bud differentiation on September 19, at Ottawa, Canada. This was true for runners rooted both on July 25 and August 22, one month later, and intervening dates. Runners 8 weeks of age, up until the middle of September, were unable to commence visible differentiation of flower buds any sooner than 4 week-old runners. Runners 2 weeks old on September 19 showed no signs of differentiation but with runners rooted after this date differentiation was evident when runners were but 2 weeks of age. There was apparently a critical seasonal period before which the stimulus for flower bud formation was lacking, independent of the age of the runner. For the variety (Pocomoke) and locality the date was September 19, the work of three years giving approximately the same results.

In northern Ohio fruit-bud differentiation is visible under the microscope in late August or early September, and probably somewhat earlier in the southern part of the State. There seems to be a decided association between the time of fruit-bud differentiation and results obtained from fall application of nitrogen fertilizer.

## FERTILIZERS

For the most part, fertilizers have been applied to strawberries with little definite knowledge of the results that may be expected from the use of different materials, amounts, combinations, or times of application. Study of the literature and of the practices of growers indicates that the response of the strawberry to fertilizer treatment has been extremely variable. In recent years, as the matter has been studied more and more in detail, certain features have been noted so that some fairly definite suggestions can be made on experimental evidence. It must be appreciated, however, that the strawberry will not respond the same under all conditions to a given fertilizer treatment.

It seems to be rather generally agreed that there is no better fertilizer for strawberries than well rotted manure; but, unfortunately, it is not always available. From 10 to 20 tons per acre is a fairly good general rate of application. Spring or winter applications of stable manure, poultry manure, or sheep manure are good if it is well decomposed before the plants are set; otherwise it may be a source of weeds, may cause reduction of stand, and may introduce other troubles. Legumes, green manure, barn manure, other manures, organic fertilizers, and lime are of more value in improving the physical condition of the soil than commercial fertilizers.

Altho there is much conflicting evidence in the literature on the value of commercial fertilizers for strawberries, some of the more recent studies, particularly with nitrogen fertilizers, have indicated some decided responses.

Loree (13) in a study of the nutrient requirements of the strawberry found nitrogen to be the chief limiting element. Nitrogen was an important factor in promoting vegetative growth and was particularly important at the time of fruit-bud differentiation. Spring applications of nitrogen, alone or in combination with phosphoric acid and potash, caused vigorous runner production. When equal amounts of the same nutrients were applied during the summer period, few runners were produced and there was a better development of the crowns. Plants treated with nitrogen during the previous summer grew better in the spring of the fruiting year than the unfertilized, or the spring-treated (first year) plants. When nitrogen was applied in the spring of the fruiting year the response in vegetative growth was greater in plants grown under low nutritive conditions the preceding summer and fall.

Phosphorus alone apparently had no effect on vegetative growth. In combination with nitrogen it promoted a larger vegetative growth and fruit production than was secured with nitrogen alone. With a limited supply of nutrients in the soil the roots were larger in proportion to the tops. With a moderate supply of nutrients the root system was less extensive and the tops proportionally larger. When phosphoric acid and potash were used in combination with nitrogen the proportion of tops to roots was larger than when nitrogen was used alone. The total number of flowers per plant as modified by fertilizer treatments was determined chiefly by the number of clusters, and to a limited extent by the number of flowers per cluster. Fertilizers containing nitrogen increased the number of flower clusters per plant.

The summer-treated plants produced nearly twice as many clusters as the spring-treated plants. Applications of fertilizers in the spring of the fruiting year did not affect the number of clusters or the number of flowers per cluster. The proportion of flowers that set fruit was influenced to some extent by the nutritive conditions that existed in the plants the preceding fall, and to a considerable extent by nutritive conditions in the soil at blossoming time. Summer-treated plants, which contained more nitrogen at the termination of growth in the fall, set a larger percentage of blossoms than spring-treated

plants low in nitrogen. Applications of nitrogen in the spring of the fruiting year caused a better setting of the blossoms and an increase in the size of the berries.

Nitrogen alone or in combination with phosphoric acid and potash in every instance increased the total yield. The yield of the summer-fertilized plants was larger than that of the spring-fertilized plants. Largest yields were obtained from plants that were fertilized in both spring and summer and again in the spring of the fruiting year. Variations in the nitrogen content of the plants at the time of fruit-bud differentiation had a greater effect on the yield of fruit than variations in carbohydrate content. Low nitrogen was associated with low yields, high nitrogen with high yields. Plants with a high nitrogen content and a high carbohydrate content were most productive. The size of the crown was not an index of fruitfulness. Total production was determined by the number of flower clusters and the number of blossoms that set and developed into fruits. These were determined chiefly by nutritive conditions within the plant at the time of fruit-bud differentiation during the late summer and fall. There was no indication that fertilizer treatments materially affected the moisture content, the texture, or the quality of the fruit.

Macoun and Davis (7, 15, 16) concluded that there are at least three ways in which applications of a nitrogen fertilizer may affect the yield of strawberries: (a) by causing an actual increase in the number of fruit buds formed; (b) by causing an increase in the size of the individual fruits; and (c) by increasing the set of the bloom. The first factor was considered as probably the most important. With stolons permitted to remain in their original position it was found by Davis at Ottawa, Canada, that there was decided correlation between the date the stolon rooted and the ultimate number of fruits it produced. Stolons formed as late as October 20 produced an average of only 5 fruits; those formed about the middle of August produced 16 fruits. Runners formed much earlier than this produced 9 or 10 fruits. Apparently the reason for the falling off of extremely early-formed stolons was due to their being the parents of large numbers of stolons and, like the original parents became depleted of energy. The number of these early, poor yielders was comparatively small.

The most profitable period of stolon formation was between the latter part of July and the last of September. Altho more than one-third of the stolons were formed in October, they produced only 19.6 percent of the crop, which, when compared with 34 percent of the crop produced by one-fourth of the stolons which were formed in August, demonstrated the great value of early planting and good care in the early part of the season.

Further work by Davis showed that when a heavy application of manure was made the year previous to planting and the land used for a hoed crop, there was on good soil a sufficient supply of nitrogen and other plant food to encourage maximum runner formation in the early part of the season. This series of experiments demonstrated, however, that even tho there appeared to be a sufficient supply of nitrogen to promote maximum runner formation, an application of nitrogen made in September of the planting year increased the yield. The exact yields of the plots treated at various times were as follows:

TABLE 4.—Yield From Nitrogen Fertilizer Applied at Different Times. From Macoun and Davis (17)

| Treatment | Yield per plot |
|---|---|
| | *Lb.* |
| Not nitrated | 19.10 |
| Nitrate one month after planting | 22.30 |
| Nitrate, August 15 | 23.00 |
| Nitrate, September 15 | 23.30 |
| Nitrate, September 15 and again in spring | 24.20 |

There was a gain of more than 4 pounds per plot from the application of nitrogen at the time when a large number of plants were forming fruit buds for the next year's crop.

Davis found also that the size of the individual berry or fruit may further affect the total yield. This might be influenced by spring applications of nitrogen, especially in soils where nitrogen is deficient. Spring applications of nitrogen might also increase the yield by improving the set. As in size, this would be more evident in soils low in nitrogen. Results from the experiments at Ottawa indicate that the total set of bloom was increased 5 percent by a spring application of nitrogen fertilizer before bloom. A closer analysis showed that the increase on the later blooms, such as the quartenary or last formed blossoms, ran as high as 26 percent.

Hill and Davis (11) found that spring applications of fertilizer failed to increase the number of fruit buds. This, in the light of cytological studies, showed that the initiation of fruit-bud differentiation was delayed until approximately September 19. Highest yields were secured with fertilizers applied on September 15 of the first year and August 15 of the fruiting year, dates that are close to the beginning of fruit-bud differentiation.

Nutritional studies with Premier in quartz sand by Whitehouse (28) seemed to show that fruitfulness in the strawberry plant is correlated with a balance between nitrogenous and carbohydrate materials in the plant at the time of fruit-bud differentiation. A weakly vegetative type of growth and a reduction in the number of blossoms formed were associated with highest carbohydrate and lowest nitrogen content, or an abnormally high carbohydrate-nitrogen ratio. A strongly vegetative type of growth and a reduction in the number of blossoms formed were associated with the lowest carbohydrate and highest nitrogen content, or an abnormally low carbohydrate-nitrogen ratio. On the moderately nitrated plots a vegetative type of growth intermediate between that made by the plants on the high and no nitrogen plots was associated with a carbohydrate-nitrogen ratio intermediate between that of the high and no nitrogen plots. Likewise an increase in blossom formation on the moderately nitrated plot was associated with a carbohydrate-nitrogen ratio intermediate between that of the high and no nitrogen plots.

In 1928, 1,500 Premier plants were set out at Wooster to study the effects of nitrogen fertilizer applied at different times. Sulfate of ammonia was used as the source of nitrogen. The plants were set early in April and only one died. The bed contained 100

rows of 15 plants each. The entire bed received a light application of rather strawy poultry manure in the winter previous to setting the plants, and 300 pounds of superphosphate and 100 pounds of muriate of potash per acre were drilled in when preparing the soil for planting. Each third row was a check. The two rows between each pair of checks received sulfate of ammonia, in addition to the bed treatment, applied at different times but usually the same amount. There were 12 rows of each nitrogen treatment adjacent to checks, except that there were only 3 rows for each of the 50- and 500-pound applications. The treated plots and checks were systematically distributed over the area.

**TABLE 5.—Yield From Runners Formed in Different Months the Previous Season, Premier**

| Runners rooted 1928 | | Yield 1929 | Yield per plant 1929 |
|---|---|---|---|
| *Time* | *No.* | *Qt.* | *Qt.* |
| June | 162 | 21.9 | 0.14 |
| July | 1989 | 79.0 | .06 |
| August | 3884 | 131.1 | .04 |
| September—October 15 | 1127 | 13.9 | .01 |
| October 16—November | 3375 | 23.2 | .009 |

The first 25 rows were selected for comparison of yield from runners rooted in different months during the season. Stakes for the runners formed in each month were painted a different color or marked with tacks and yields recorded in 1929 from the respective groups. The early rooted runners were more productive than later ones, Table 5. Altho there were, of course, more runners rooted late than early, the relative value was 15 times as great for the runners formed in June as for those rooted after October 15.

**TABLE 6.—Effect of Nitrogen Fertilizer (Sulfate of Ammonia) on Yield of Premier**

| Sulfate of ammonia per acre | Yield per acre (1929) | Increase per acre over check (1929) |
|---|---|---|
| *Lb.* | *Qt.* | *Qt.* |
| Check, none | 6,253 | ..... |
| 50, at planting | 6,379 | 126 |
| 250, at planting | 6,384 | 131 |
| 500, at planting | 6,394 | 141 |
| 250, a month after planting | 6,464 | 211 |
| 250, August 15 | 6,539 | 286 |
| 125, at planting and 125, August 15 | 6,551 | 298 |
| 125, a month after planting and 125, August 15 | 6,716 | 463 |

Some results in 1929 from nitrogen fertilizer applied at different times during 1928, the year of planting, are given in Table 6. It must be appreciated that this experiment was limited as to time,

soil, weather conditions, etc. In this plantation sulfate of ammonia, in each of the different time applications increased yield. Application of August 15 seemed to be of most value, probably being timely with respect to maximum rooting of runners and fruit-bud formation. Highest yield was obtained from a split application, a month after planting and August 15. Nitrogen increased size rather than number of plants.

Sulfate of ammonia applied at the rate of 250 pounds per acre, early in the spring of the first fruiting year, resulted in a lower yield during the first half of the picking season but in a higher yield during the later pickings, than the untreated rows; and the total yield from the spring fertilized rows was lower than from the untreated rows. The spring application also resulted in foliage of a much darker green color, an increased amount and density of foliage; relatively slower picking; and larger berries during the later part of the season. It is often claimed that a quickly available nitrogen fertilizer during the spring of a fruiting year tends to make the fruit softer. Possibly this may be so. Softness of fruit, however, seems to be influenced more by rainfall and other weather conditions than by fertilizers. Early spring applications of nitrogen fertilizer may be an advantage where an increase in late pickings is desired. The results might be somewhat different if the rate of the spring application were changed; for example, 100 to 125 pounds of sulfate of ammonia per acre instead of 250 pounds, the rate used in this experiment.

**Table 7.—Yield of Check Rows and Rows Receiving Sulfate of Ammonia Early in Spring of First Fruiting Year, 1929**

| Treatment | Yield in quarts | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | June | | | | | | | | | | July | | Total |
| | 8 | 11 | 13 | 15 | 17 | 19 | 21 | 24 | 26 | 29 | 1 | 3 | |
| Early spring | 2.6 | 13.9 | 33.9 | 46.7 | 46.0 | 28 7 | 40 3 | 41.7 | 35.2 | 27.8 | 19 2 | 6 3 | 342.3 |
| None. . . | 3.6 | 21.8 | 41.8 | 57.8 | 52.3 | 34.5 | 47.4 | 39.6 | 32 6 | 26.9 | 17.7 | 5.9 | 381.9 |

Suggestions for fertilizing strawberries may be given as follows: (a) Build up a supply of decayed organic matter or humus in the soil by turning under a legume or green manure crop, or barn manure previous to planting strawberries. (b) If it seems necessary, apply lime at least a year in advance of strawberries, altho light applications may be made if desirable when fitting the soil for the planting. (c) When preparing the soil, work in phosphorus and potash fertilizers, such as superphosphate 250 to 300

pounds and muriate of potash 50 to 100 pounds per acre; or a complete fertilizer may be applied at that time. (d) During the first year, applications of a nitrogen fertilizer can sometimes be made to advantage about a month after planting and again in mid-August or early September. If only one application of nitrogen is made, mid-August or early September is probably the best time for it. Try 250 pounds per acre of sulfate of ammonia or a corresponding amount of other nitrogen fertilizer. (e) Under some conditions application of nitrogen may be advisable early in the spring of the fruiting year. (f) When renewing the beds apply a fertilizer high in nitrogen, also some phosphorus and potash.

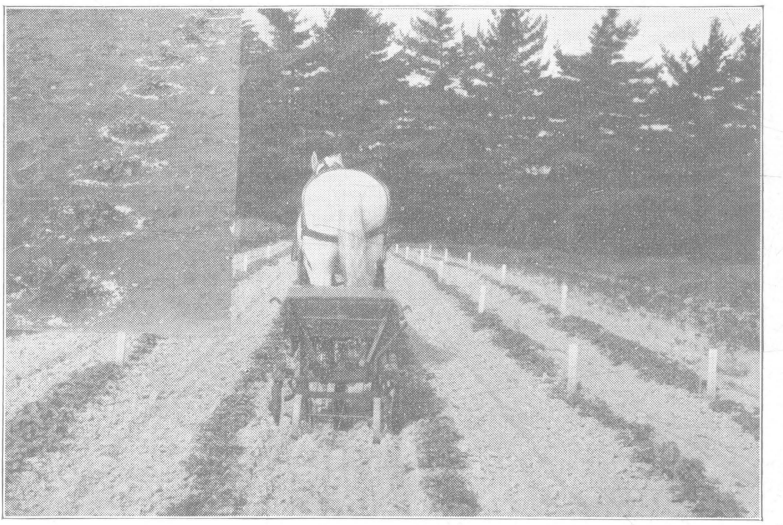

**Fig. 10.—Drilling fertilizer; "Spouts" at each side only are open. Fertilizer applied by hand a month after planting (inset)**

Commercial fertilizer applied when preparing the soil for planting is usually drilled in with a grain drill. Care should be taken in applying fertilizers such as sulfate of ammonia or nitrate of soda to avoid damage thru burning. Applying the material near the plants but not in direct contact with the foliage or crowns is good, safe procedure after planting, during the first season and when renewing a bed; this may be done either by hand or with a small drill. If such fertilizer be applied directly over the plants, the best time seems to be when the foliage is dry. Should a heavy rain immediately follow this application very little injury from burning will result. If a timely rain does not follow, it is a good

plan to drag a broom or a burlap sack over the plants to brush off any fertilizer on the plants. In the experiment with Premier some of the straw mulch was removed and the sulfate of ammonia applied in early spring of the first fruiting year on top of the remaining temporary covering.

## IRRIGATION

A few timely irrigations some seasons may save or increase the crop. On the other hand, in some seasons little or no appreciable benefit is derived from irrigation. For irrigation to be practical there should be an abundant supply of water near the field.

With the usual overhead irrigation systems water is applied from pipes under pressure, and since it is delivered as a fine spray need not pack or puddle the soil. The cost of installing a permanent overhead system is roughly estimated as $250 to $300 per acre. More definite information on cost may be secured from the manufacturers.

One of the chief objections to overhead irrigation is the cost of installation. Sometimes, however, it is practical and profitable to install an irrigation system, particularly for intensive culture. Strawberries sometimes are grown along with vegetables under overhead irrigation; strawberries can be rotated so the cost of installation may be borne in part by other crops. Irrigation systems may be permanent or movable, or be furnished by surface means. Some growers have adapted means of irrigation made possibly by their local conditions.

At the Experimental Farm, Ottawa, Canada, an overhead system of irrigation has been in operation since 1915. Macoun and Davis (18) stated that the results from this system have not warranted unreserved recommendation of its adoption for commercial strawberry growers. In the first place, the system cost, at the time of installation, about $400 per acre. This figure included pumping outfit and everything complete for operation. Upkeep was very light, about $4 a year per acre, including replacing split pipes, new valves, damage done by teams, cost of cleaning the system in the fall and labor for going over it once a year to tighten up loosened joints, etc. At $400 original cost this made an overhead of about $32 per acre without considering depreciation. If the life of the system were placed at 30 years, it would be necessary to write off about $14 a year, bringing the total overhead to $46 an acre per year.

During the first year of the plantation irrigation may increase runner formation, particularly during drouth periods. When drouths occur during the fruiting season the berries may not reach full size and the picking season may be shortened. An efficient

irrigation system not only affords a means of avoiding drouths but may also be used in early morning to avoid damage from light frosts during bloom. In certain respects, irrigation might be of more advantage to a fall than to a June bearing variety.

## MULCHING

After the ground is frozen firmly the strawberry bed is mulched with straw or other suitable material. Altho mulching is not absolutely necessary, it is useful for a number of reasons. As a winter protection it checks heaving of plants and breakage of the roots caused by thawing and freezing. In spring and early summer it tends to prevent injury from frosts by delaying blossoming, keeps down weeds (provided the material is free from weed seeds), conserves moisture, replaces cultivation, reduces the number of dirty berries, and makes picking more pleasant. Mulching also improves the color of the fruit according to some observations.

**Fig. 11.—Mulching retarded bloom several days, reduced amount of heaving out, and avoided dirty berries**

Oats, rye, buckwheat, hay, leaves, shredded cornstalks, pine needles, and other materials are used by growers, but they are inferior to good clean wheat straw. It is important to use mulching material that is free from seeds, that does not pack down and cause smothering, and that is not too coarse nor so light that it blows away. Clean wheat straw is usually applied several inches deep, both over and between the rows. Three to five tons per acre is a good mulching. Strawy manure sometimes gives good results,

but it is likely to contain weed seeds and may not keep the fruit as clean as wheat straw. If a plantation becomes very weedy, the yield is reduced and renewal for another crop is likely to be unprofitable. Baled straw, when used, should be thoroly torn apart.

The berries from the unmulched plots, Table 8, were dirty and on this account brought a considerably lower price than the mulched berries. The unmulched plot led in early production but was outyielded for the season by the clean wheat straw plot. Presence of seeds in the mulching material reduced the yield.

**TABLE 8.—Yields of Plots Mulched With Clean Wheat Straw, No Mulch, and Wheat Straw Containing Many Weed Seeds. Gibson, First Fruiting Year. Wooster, 1928. Quarts per Plot**

| Treatment | June | | | | | | July | | Total |
|---|---|---|---|---|---|---|---|---|---|
| | 19 | 21 | 23 | 25 | 27 | 29 | 2 | 5 | |
| Clean wheat straw | 0 9 | 5.1 | 12.0 | 18 5 | 20.0 | 19.0 | 31.0 | 12.5 | 119.0 |
| No mulch | 9 0 | 12.0 | 18 0 | 15 8 | 13.8 | 15 2 | 10.5 | 5.0 | 99.3 |
| Weedy wheat straw | 1 5 | 5 3 | 9 4 | 10.9 | 12 6 | 17 5 | 25.0 | 6 3 | 88.5 |

Sometimes a cover crop of oats is sown in late summer or early fall between the strawberry rows and allowed to mat down as it is killed by frost. This subject was discussed more than 20 years ago by members of the Ohio State Horticultural Society, some expressing the opinion that the oats in dry periods take moisture from the strawberry plants and that in wet periods grow so rank as to shade the plants and crowd their roots. There was some belief, also, that the size of berries might be smaller than usual with this system. If a crop, such as oats, be grown for a mulch in a strawberry plantation, it is usually necessary to supplement it with a light covering of straw or other material.

With everbearing varieties, which fruit in late summer and fall following the spring they are set, it is a good plan to use some suitable mulching material around the plants after the berries begin to ripen to keep down weeds, conserve moisture, and avoid dirty berries.

Take off the mulch in the spring after danger of frost is past but before there is appreciable "paling" of the leaves. If the covering is thin the plants grow up thru it. If it is fairly heavy, however, it is best to rake most of it off the plants with a fork into the alleys between the rows, tramp it down, and leave it until after the picking season. At Wooster the straw mulch is usually removed during the latter half of April. It is customary to remove

the mulch from propagation rows earlier than from fruiting rows. After the mulch has been removed, weather conditions sometimes make it advisable to again cover the plants for a short time.

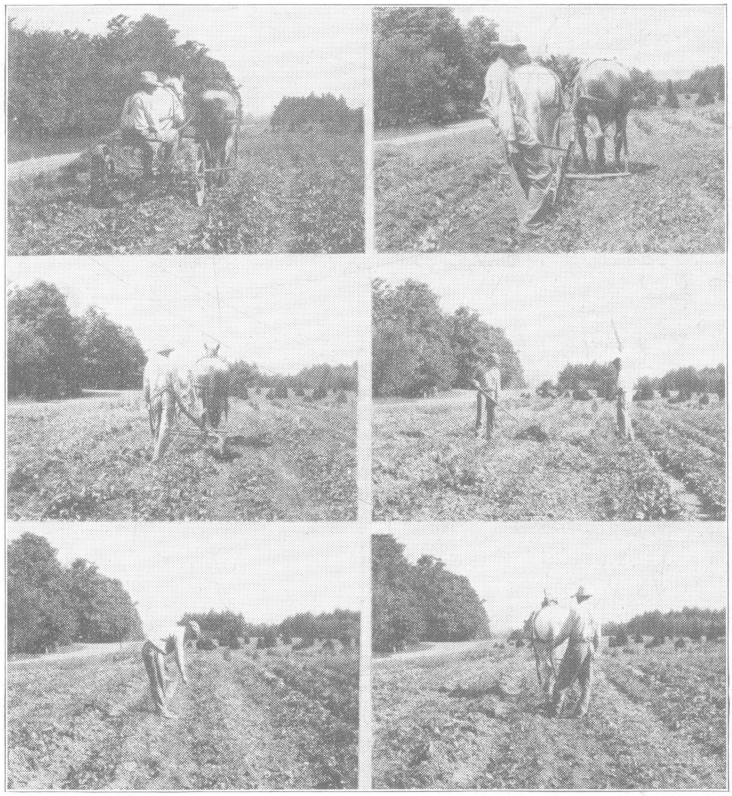

**Fig. 12.—Renewing beds. Left to right: mowing foliage, narrowing rows with plow, narrowing rows with grape hoe, shaking out plants after using grape hoe, fertilizing, cutivating**

Several methods of mulching strawberries with paper are being tried at the Ohio Experiment Station. Altho such material possesses some advantages there are also some marked drawbacks still to be overcome. At the time of writing, the use of paper for mulching strawberries is not recommended, except in a limited way for trial.

## RENEWING THE BEDS

### DURATION OF PLANTATION

Many strawberry growers fruit their plantation only once and then turn it under. With such a practice new plants are set each year, entailing the expense of the plants, setting, and care for

every crop obtained, and two years use of the land for only one crop. Quite often, however, fruiting the plantation only once is most profitable.

Much too frequently with a second crop the yield is low; the berries decrease rapidly in size and are of poor appearance; picking is slow and tedious; heaving out materially reduces the stand; infestation of diseases and insects is serious; and drouth causes considerable damage. While all or some of these drawbacks may be the fate of a second-crop bed, it is not the intention here to infer that renewing the beds is always unprofitable. Successful renewal makes production costs for the second crop less than for the first. Second crop berries usually ripen slightly earlier than first crop berries. It is because of the fact that beds in good condition can be renewed profitably that methods of procedure for this are outlined.

Renewing the plantation a second time so that three crops are harvested is a precarious proposition and is seldom advisable. Frequently, beds are neglected after one or more crops have been harvested, the grower reasoning that any fruit picked thereafter is produced with little effort on his part and therefore any fruit sold is so much gained. Sometimes neglected or haphazardly renewed beds produce enough fruit to be worth picking, but commercially the fact that the land might be used more profitably for some other purpose should be considered, as well as the disadvantages mentioned in the previous paragraph.

### PROCEDURE IN RENEWING BEDS

**Removal of mulch.**—The mulch material between the rows, particularly when heavy, should be gathered up and removed from the plantation, or be burned. Leave no more than such quantity of the mulch as may be readily incorporated in the soil, or that will burn rapidly.

**Mowing the foliage.**—Sometimes the tops of the plants are mowed soon after the picking season, with the cutter bar of the mower carried high enough to avoid injury to the crowns. Mowing the foliage, providing the mowings are removed from the plantation and burned, may be of some value in controlling leaf spot, as the fungus associated with the disease overwinters on infested leaves; however, since some of the disease is certainly left, mowing may not be as effective as commonly thought to be. Some of the older varieties, like Wm. Belt, are more susceptible to leaf spot than some of the newer ones, like Premier. Introduction and extensive planting of Premier has led many growers to discontinue mowing

the tops for leaf spot control. Some growers claim that mowing the foliage is a sanitary process for the plantation, that growth is stimulated, and that further renewal is facilitated. Probably more claim that the removal of healthy foliage is detrimental and stunts development of the plants.

**Burning over the beds,** altho rather commonly practiced is not a necessary operation and is probably not the best method of procedure for renewing beds that are in good condition. It is sometimes used to advantage for plantations in which weeds, leaf spot, and other troubles require drastic treatment. Burning, like mowing, destroys healthy foliage.

Delay burning until the mowed foliage and mulch material are relatively dry, but the soil moist, and until there is sufficient breeze that the blaze sweeps quickly across the plantation. Do not burn over the beds during a drouth period as the plants are likely to be damaged. Damp foliage or mulch material may result in slow passage of the fire and injury to many of the plants. To overcome this difficulty, shake with a hay tedder or first remove the material from the plantation and then loosely scatter a thin layer of the driest of it over the bed. The process may be helped by placing burning material with a fork at advantageous positions thruout the plantation. Some mulching materials are difficult to burn properly and some varieties of strawberries are more sensitive to heat than others.

**Narrowing the rows.**—There are, in general, four systems of renewing the rows: (a) systematically turning under one side, so as to narrow the row and leave the newer plants on the outer edge as the remaining strip; (b) narrowing the row from both sides so that the center is left; (c) working out the center of the row and leaving strips on both sides of it; and (d) rows not narrowed.

A plow may be used in turning under one side in the first method. A harrow or cultivator then levels the soil and tears out the plants that were turned under. Many growers consider that results from this method are not commensurate with the cost. The plants that were turned under are sometimes hoed out but this is a laborious operation. Failure to remove these plants is not conducive to success. It is not easy to tear out the plants and work the soil between the rows into good condition soon after plowing. When the rows are not more than 3 or 3½ feet apart and an ordinary farm plow is used the adjoining rows sometimes become covered with soil; a light covering of soil thrown up to plants of varieties with relatively high crowns, such as Premier, may be of

some benefit but too much covering damages the plants. As a time saver use of a small two-way, reversible, or hillside plow, is preferable to an ordinary plow.

An elevator type of potato digger may be used and possesses some advantages over the plow for narrowing rows but it is not a very satisfactory method.

A grape hoe for narrowing the rows seems to possess merit. This method was developed and used at the Ohio Experiment Station for the first time in 1928. Before using the grape hoe, rake up the mulch material and remove it from the plantation. Keep the hoe sharp so that it penetrates to a depth of 1½ inches. It may sometimes be necessary to tie a weight, such as a heavy stone, on it. About half of each row, always the same side of the rows, is sliced off and the plants between the rows are laid up in such manner than they may be gathered much more readily than when a plow is used to narrow the rows. A litter fork is a useful implement for raking up the material. Then, by running a cultivator between the rows the soil can be prepared in excellent condition. Narrowing the rows in this way seemed to give better results than other methods.

A system often followed is to narrow the row from both sides and leave a strip of plants in the middle. Sometimes a small plow is used to turn a furrow from each side into the space between the rows. More frequently a cultivator with strong teeth is used on soil that is relatively light and not too dry.

Another system is to work thru the middle of the row and leave a narrow strip along each side, usually by means of a type of plow specially adapted for this purpose.

Systems of renewal that do not narrow the rows depend primarily on thinning out the plants in the row. In some cases the work cannot be undertaken until it is too late to do more than make a narrow pathway between the rows, leaving nearly all the plants untouched. This plan gives unsatisfactory results, but in an exceedingly dry season there may be no better way.

**Thinning the plants in the row.**—Some of the chief purposes of thinning are to avoid too crowded conditions in the row; to remove old plants; and to afford opportunity for plants that are to fruit the next year to grow as large, vigorous, and thrifty as possible. Some thinning of plants in a narrowed row is usually desirable but the necessity, time, system, and response depend to a certain extent on circumstances.

Weather conditions of late summer and fall, type and condition of soil, prevalence of weeds, age of plantation, variety, and other factors affect the manner and degree of thinning. Thinning after renewal is a somewhat different proposition than during the year the plants are set, due largely to the fact that in the second year renewal follows fruiting. When the plants are crowded in the rows, with favorable conditions early thinned rows may show advantage over unthinned rows or those in which thinning was delayed after renewal, providing the most productive type of plants were left and inferior onces removed. On the other hand, when conditions are unfavorable better results may be obtained by leaving the narrowed rows with a later or reduced amount of thinning, or perhaps without thinning. As a rule, when the work is done soon after the crop is harvested adequate time is afforded for well spaced strong, healthy plants to develop a good stand and make good crown growth. It should be borne in mind, that early rooted plants are more productive than those rooted later.

**Fertilizing.**—The kind and amount of fertilizer to apply when renewing beds depend somewhat on the age, vigor, and stand of plants; the plant forming characteristics of the variety; and other factors. Application of 250 pounds per acre of a nitrogen fertilizer, such as sulfate of ammonia, has given good results. Superphosphate at the rate of 250 to 300 pounds per acre, has been beneficial, but less so than the nitrogen fertilizer; likewise potash fertilizer, such as muriate of potash at the rate of 50 to 100 pounds. A high grade complete fertilizer is suitable at this time.

Macoun (16) reported experiments of Davis in which the following deductions in regard to a second crop were made: (a) Even on soils that may be termed in good tilth, artificial nitrogen fertilizers have a distinct value and may cause an increase in yield up to 65 percent. The need of this additional nitrogen may not be detectable from an observation of the vegetative condition of the plants. (b) Applications of nitrogen fertilizers made during the first fruiting season materially affected the production the second year. (c) August 15 (of the first fruiting year) seems to be as late a date as it would seem advisable to apply nitrogen fertilizers to a plantation for its second crop, while as late as September 15 during the first year gave the best results. (d) While spring applications may cause an increase in size of fruit they are of doubtful value for the second crop, altho apparently quite safe for the first.

**Cultivation.**—The sooner and more thoro the soil is worked after narrowing the rows, the better the results.

## HARVESTING

**Seasons of ripening.**—Because of its early season of ripening few other fruits directly compete with strawberries in appreciable degree, altho there is limited competition with fruits shipped in from southern states, with apples held in storage, with cherries, and a few other fruits grown in Ohio. Competition is met from strawberries shipped in from other states, from different regions within Ohio, and from growers in local sections. There is a difference of several weeks in seasons of ripening of a given variety in southern and northern Ohio. The harvesting season of Premier in 1929 at Wooster is shown in Table 7, and of Gibson in 1928 in Table 8.

Thomsen and Thorne (23) classify strawberry seasons as follows, listing states in each group alphabetically: **Early**—Alabama, Florida, Louisiana, Mississippi, Texas. **Second early**—Arkansas, California, (S. dist.), North Carolina, South Carolina, Tennessee, Virginia. **Intermediate**—California (other), Delaware, Illinois, Indiana, Iowa, Kansas, Kentucky, Maryland, Missouri, New Jersey. **Late**—Michigan, New York, Ohio, Oregon, Pennsylvania, Washington, Wisconsin.

Loree (14) pointed out that Michigan's shipping season usually begins during the first or second week in June and continues until the latter part of July. The average shipping seasons for the principal competing states were given as follows: Arkansas, April 20 to June 15; Tennessee, May 1 to June 20; Kentucky, May 15 to June 15; Missouri, May 15 to June 15; Iowa, May 15 to June 15; Indiana, June 1 to June 30; Illinois, May 15 to June 30.

**Equipment.**—When strawberries are grown commercially, attention may be given to harvesting equipment some time before the fruit ripens. A supply of crates and boxes may be ordered as soon as a reasonable estimate of the crop can be made. Some idea of the number necessary may be obtained from page 3 and Table 1, but records of local crops will serve as a better guide. The standard quart box is used almost exclusively. Crates holding 16, 24, or 32 quarts are used; the 24-quart crate probably being the most popular. Provide carriers or trays, with handles, for the pickers, that hold 4, 6, or 8 boxes. Keep crates and boxes neat, clean and undamaged. Demand and price for berries is affected when offered for sale in damaged or unattractive packages.

**Pickers and picking.**—Availability of pickers is important. Women accustomed to outdoor work are often the most efficient berry pickers. Under competent supervision boys and girls, over 12 years of age, are satisfactory. There should be enough pickers

to get over the patch at least once in two days, but yet enable them to put in as nearly full time as possible if they so desire. The number of pickers required will vary with their efficiency and the crop. While many of the pickers may be needed for only a relatively short time, many strawberry growers need additional help from early spring to late fall for such work as setting plants, transplanting vegetables, keeping weeds under control, thinning fruit, spraying, renewing beds, picking other fruits, and many other operations.

Good supervision of the pickers in the field is important. Instruct the pickers at the start regarding the stage of ripeness, or color, to look for; clean picking; picking by the stem instead of by grasping the berry; sorting while picking; filling the boxes; care in handling; avoidance of kneeling on the plants; disposition of the boxes; and other details. Stems should be left about ¼ to ½ inch long on the berries.

Careful handling is necessary. Berries crush easily and then are not attractive as market fruit. Pick over-ripe and unsound berries from the plants, even tho worthless, to avoid having some of them get into later pickings. Hold only a few berries in the hand at a time. Fruit that is over-ripe, picked when wet, or that has become soft or bruised in picking or handling is soon attacked by molds and decays quickly. Berries not marketed directly from the field should be placed at once in cold storage, a cool cellar, or other suitable place in order to retard deterioration.

**Stage of ripeness.**—The proper stage of ripeness for picking as determined by color depends upon such factors as variety and distance to market. For the most part, it varies from about ¾ to a full-red color. In general, berries ¾ red in color are suitable for a 24-hour shipment, and full color but not soft for a 12-hour shipment. For long distance shipments the berries are picked while showing considerable green or white color and while still hard in texture.

**Paying the pickers.**—Most growers pay by piece work, altho many pay by the hour or day. Often, the pickers take the carriers or trays to the shelter shed where they receive credit for the quantity picked. In large plantations it is usually necessary to use some systematic method of keeping account of the work done by the pickers. The punch card system is probably the most commonly used, but like other systems, such as the book, check, or cash, has disadvantages as well as advantages. When pickers work by piece-work they are wont to pick where the berries are thickest, to

leave the scattering fruit, and to fill the boxes as fast as they can, sometimes without due regard to careful handling or sorting. On the other hand, when pickers are paid by the hour they may not work as fast as they should.

**Shelter shed.**—Do not allow the picked berries to remain exposed to sun, wind, rain, or dust. A shelter shed can often be used to advantage; it need not be an elaborate structure but should be so located that the pickers have a minimum walk when bringing in the fruit and that it can be reached conveniently by truck or horse-drawn vehicle. Careful supervision at the shelter shed is important.

**Grading the berries.**—As a rule, strawberries in Ohio are not graded, other than some sorting while picking. Fruits of various grades can be put in different boxes in the carriers or trays. Grading in the field tends toward a minimum of handling but requires close field supervision.

Packing, when practiced, usually consists in arranging the top layer of berries so that no stems show and a neat appearance is obtained. When the crop is especially good, or the market is not too critical, it may not pay to do more than remove the very poor berries. On the other hand, it may be advisable to make two grades for critical markets.

The berries in the middle and bottom of the boxes or crates should not be inferior to the top ones.

## PROPAGATION

Growers frequently are confronted with the question of whether to propagate their own plants or buy them from nurserymen. In many cases the former is the best plan. The majority of growers, however, seem to find it better to buy their plants, as indicated by the extensive nursery trade.

Nurserymen are experienced in preparing plants for successfully shipping long distances. Sometimes, however, shipments are delayed for various reasons and the plants are damaged by heating and other causes.

When strawberry plants are grown solely for propagation purposes, the usual practice is to dig the entire rows. When digging plants from a fruiting or prospective fruiting bed, they are usually taken from the edges of the row instead of from the entire row. Digging the entire row, and discarding the old plants, undoubtedly furnishes the best plants for setting. At times propagating plants is a profitable side-line to the sale of berries; at other times, fruiting the rows is more profitable.

There is usually a rush of spring work at strawberry planting time. It is important to have a supply of plants conveniently at hand to avoid delay in planting. Conditions with some growers are such that they can afford the time to dig and clean their own plants whereas other growers cannot. It is annoying to begin planting and then have to stop until more plants are dug and cleaned.

Plants well cleaned, with evenly bunched, straight roots, make setting easier, quicker, and better. It is often difficult to obtain high quality plants in heavy, hard soil. There are some claims of advantage for setting plants with a certain amount of soil attached but a perfect stand is commonly obtained from plants from which the soil has been washed.

When a grower propagates his own plants he can perpetuate a variety or varieties of known behavior under his local conditions. The variety may be one that is not commonly listed by nurserymen but that is well adapted to the grower's particular conditions. Sometimes plants bought are not true to name. Ill effects that sometimes are thot to occur when plants are grown under different soil and environmental conditions are avoided when a grower raises his own plants.

In order to keep varieties true to name the strawberry, like other fruits, is perpetuated by bud propagation. This is accomplished by means of runner plants. The slender runner stems, in contact with soil in suitable condition, take root at a node and form new plants. A root system is developed by runners that finally become independent plants, themselves able to send out runners. New varieties originate from seed.

**For spring planting.**—For spring planting, parent plants that have not fruited are set one spring and the new plants dug the next spring.

Under average conditions the following is a fair estimate of production per each parent plant: Ratios, of course, vary greatly; sometimes, for example, 50 new plants are obtained from each parent plant of Senator Dunlap.

| | |
|---|---|
| Senator Dunlap 20 | Sample 14 |
| Aroma 16 | Premier 10 |
| Gibson 15 | Chesapeake 6 |

With plantations solely for propagation purposes more than 100,000 plants per acre should be obtained, altho such an estimate is influenced by many factors; the usual range is between 75,000 and 200,000 plants to the acre.

The following data were obtained on runner formation of Premier at Wooster in 1928, a season characterized by drouth periods during parts of May, August, September, and October, and by plenty of moisture for the plants during April, June, and July. Premier often has not been as prolific a plant maker as desired.

**Fig 13.—Plantation in which runner and fertilizer studies were conducted with Premier. Nearly 40,000 runners were staked**

Records were kept of 37,252 runners. Of this total, 387 runners, or 1 percent rooted in June; 6,568, or 17.6 percent in July; 10,310, or 27.6 percent in August; 2,602, or 6.8 percent between September 1 and October 15; and 17,384, or 46.6 percent formed but only a small part rooted after October 15. Altho the number of runners rooting in June was small, there was a correlation between the number rooted in June and at later periods, Table 9. This serves to emphasize the importance of getting the plants off to a good start; early planting, well prepared soil, and good plants are very important.

**TABLE 9.—Number Runners Rooted per Row of 15 Plants, Wooster, 1928**

| June | Number runners rooted per row | | | | | | Runners per parent plant | |
|---|---|---|---|---|---|---|---|---|
| | July | August | Sept.—Oct. 15 | Oct. 15—Nov.* | Total Oct. 15 | Season* | Oct. 15 | Season* |
| 1 | 53 | 77 | 21 | 176 | 152 | 328 | 10 | 22 |
| 3 | 62 | 86 | 21 | 186 | 172 | 358 | 11 | 24 |
| 5 | 71 | 124 | 29 | 170 | 227 | 397 | 15 | 26 |
| 7 | 77 | 123 | 31 | 176 | 238 | 403 | 16 | 27 |
| 9 | 73 | 140 | 34 | 163 | 255 | 418 | 17 | 28 |
| 12 | 96 | 122 | 46 | 153 | 274 | 427 | 18 | 29 |

*These columns include runners formed, few rooting after Oct. 15.

**For summer and fall planting.**—Strawberries are propagated in pots to a limited extent for summer and fall planting. This is an expensive method but may be practical under certain conditions, as fruit can be obtained the following year.

The subject of potted strawberry plants was discussed by Matthew Crawford (4), Cuyahoga Falls, Ohio, more than 20 years ago, as follows:

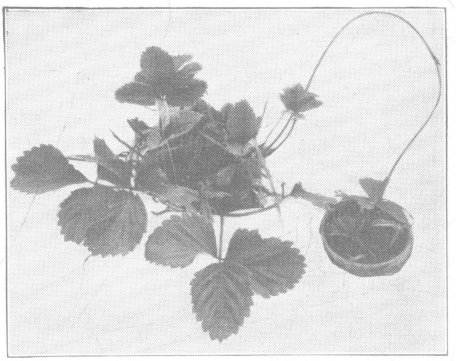

**Fig. 14.—Plants are sometimes propagated in pots for summer or fall planting**

Potted strawberry plants have been used about half a century. They were produced to supply a demand for plants that could be transplanted in the summer time when extra care and skill are required to do this work successfully. They are produced in three ways, all of which have their advantages. In all these methods it is advisable to have early runners. The common method is to fill two-inch pots with loamy soil and sink them to the rim alongside of the runners to be potted, and place one in the center of each, holding it in place with a small stone. In favorable weather the pots will be filled with roots in two weeks. They are then severed from the old plant and carried to a frame where they can be shaded and watered for a few days while they learn to get their food thru the roots instead of depending on the plants that produced them. Another plan is to cut off the young plants as soon as they have roots an inch or two in length and pot them and put them in a frame at once. With good care they are ready for planting in two weeks. Still another way is to level up the earth in the frame, place empty pots an inch apart and sift potted soil over them till they are more than full, then level off with a broom. Then take runners with the roots just starting, carry them to the cellar or any sheltered place and trim them, cutting off the runners extending beyond the node, and shortening the main runner to an inch. As each one is trimmed throw it into a pail of water. Then carry the pail of cuttings to the frame and place one in each pot, pushing the runner into the soil until the part from which the roots are sent out is well into the earth. Then with the thumb and two fingers press down the soil and cutting, leaving the pot about two-thirds full. Water well and shade, giving less shade each day until the young plants are rooted and self-supporting. These are the methods commonly adopted. The first one is the best for beginners, and the second for those of more experience. The third plan if well carried out is excellent, and less costly than the others. The disadvantages of potted plants are that they are costly, their transportation is expensive, they must soon be used or they become pot-bound, and crown borers and root worms may be carried from the old bed to the new. For the amateur who wants the best results regardless of cost, they fill a place. For the trucker who can produce his own potted plants they may

yield a profit; but the person who expects to raise berries for market from potted plants that he has to buy and pay express charges on is in a fair way to be disappointed. He can raise fine fruit but not enough of it. To succeed with them they should be planted about the first of July. Every day the work is put off after that date diminishes the crop. The ideal potted plant is produced by laying a strong runner in a three-inch pot as early as runners can be obtained. Let it remain attached to the old plant two weeks and then keep it in a frame for a week and then plant.

## HANDLING PLANTS FOR SHIPMENT

It is advisable to obtain plants from good plantations of the desired varieties near where they are to be grown. This reduces the time between digging and planting and keeps down transportation charges. Every day that strawberry plants are out of the ground may lower their vitality greatly. Many successful growers wisely insist on going to the propagation plantations to obtain plants and then setting them directly in their fields, the same day if possible. The majority of plants raised, however, have to be prepared for shipment.

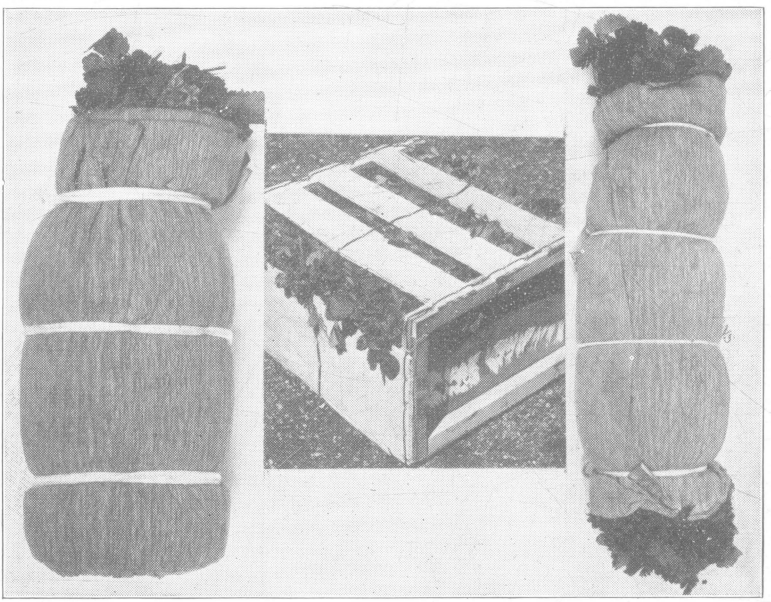

**Fig. 15.—Some methods by which plants are prepared for shipment**

Do not expose plants to wind or sun more than necessary during digging or they are likely to dry out. Immediately after the plants are dug cover and take them to the packing shed, storage room, or heel-in, if shipment is not to be made at once. Keep the

packing shed cool and free from drafts. Have at hand a quantity of sphagnum moss or other suitable material, as well as containers and other packing equipment.

In packing, surround the plants with sphagnum moss well soaked and squeezed free of surplus water. The proper amount of moisture to leave in the moss depends on such factors as the distance the plants are to be shipped, the type of container, the number of plants in the container, and the temperature. Pack and ship only plants with good thrifty root systems.

Small orders, of say two dozen plants, can be done up in pliable wrapping material available in commercial forms, altho oiled and heavy wrapping paper are commonly used. Some of the foliage is usually left exposed. Baskets, lined with oiled paper and moss and covered with burlap are suitable for many orders. An 11-quart basket without handles is useful for 100- or 200-plant orders. For larger orders, strawberry crates and boxes with openings for ventilation are commonly used.

## VARIETIES

### PEDICEL PUBESCENCE

Upshall (24) Ontario Horticultural Experimental Station found that there are two well marked and distinct types of pedicel pubescence, adpressed and outspreading, and that all strawberry varieties can be assembled in either one or other of these classes. Upshall wrote the following statement on outspreading and adpressed pedicel pubescence:

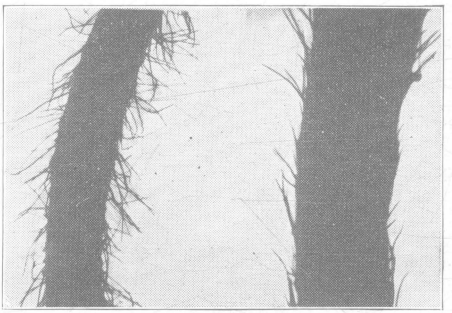

**Fig. 16.—Outspreading (left) and adpressed (right) pedicel pubescence. (Pedicel is the stem supporting individual berries).**

> Adpressed pubescence means that the hairs are lying more or less closely to the pedicel and pointing towards the inflorescence. In some varieties the hairs are not very closely pressed against the pedicel, for example, in Dunlap, but even here there is no mistaking it for the 'outspreading pubescence' type since in the latter the hairs are either at right angles to the pedicel or pointing slightly downward as in Parsons Beauty; in other words, altho the types deviate from the normal slightly it is not difficult with the naked eye to distinguish one from the other. There seems to be no true intermediate in crossing the two types.

Varieties are assembled, according to type of pedicel pubescence—the first 7 varieties under *outspreading* and the first 11 under *adpressed* were taken from Upshall (24), the remainder from other varieties at Wooster—as follows:

OUTSPREADING

1. Aroma
2. Parsons Beauty
3. Portia
4. Progressive
5. Rockhill
6. Vanguard
7. Williams
8. Cooper
9. Ford
10. Glen Martin
11. Leman
12. Lord Salisbury
13. Pearl
14. Town King

ADPRESSED

1. Belt
2. Big Joe
3. Big Late
4. Chesapeake
5. Dunlap
6. Gandy
7. Glen Mary
8. Klondike
9. Premier
10. Missionary
11. Sample
12. Aberdeen
13. Beacon
14. Bliss
15. Boquet
16. Brandywine
17. Brico
18. Cassandra
19. Chaska
20. Delicious
21. Dr. Burrill
22. Easypicker
23. Jumbo
24. Lucky Strike
25. May Queen
26. Maximus
27. Minnehaha
28. Nokomis
29. Stevens Late
30. World Wonder

DESCRIPTIONS

**Premier,** Howard (9), Howard 17 (21).—Fruit long conical to wedge conical; large; holds up well in size but may be small during the last pickings; reasonably firm; bright red color; attractive appearance; good quality. Double berries rather frequent early in season. Highly productive. Only fair plant maker. Pollen production not as abundant as with many other varieties. Tips of teeth of leaves greenish or faintly tinged with red in contrast to the dark red of Gibson. Foliage exceptionally free from leaf spot. Ripens early and over a long season. The outstanding variety in Ohio.

**Sample** (imp.).—Fruit regular, round-conic, medium size; rather coarse grained; not as dark colored as Gibson; only fairly firm. Productive. Prolific plant maker. Ripens midseason. Grown in certain parts of the State.

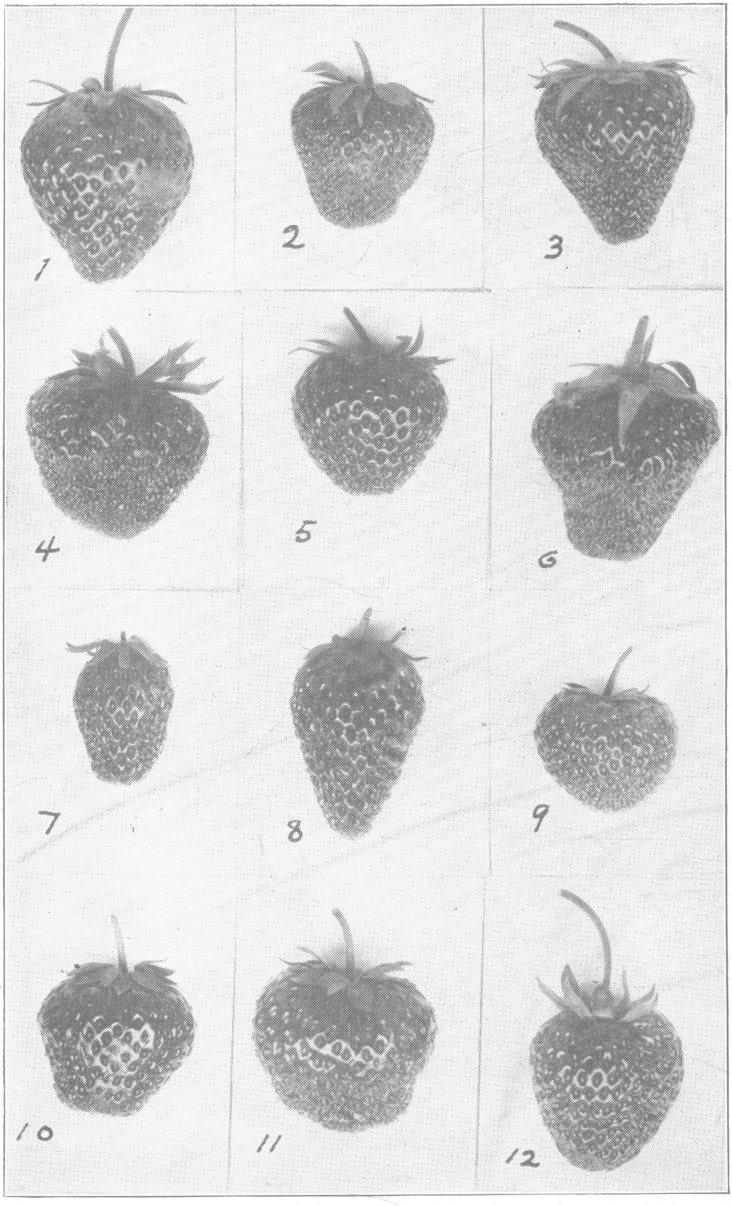


Fig. 17.—Variety specimens: 1, Premier; 2, Gibson; 3, Sample; 4, Wm. Belt; 5, Aroma; 6, Cooper; 7, Dunlap; 8, Cassandra; 9, Lucky Strike; 10, Beacon; 11, Boquet; 12, Bliss

**Gibson** (per).—Fruit wedge conical; medium size; firm; dark red; somewhat sour. Productive. Prolific plant maker. Ripens midseason. Follows Premier in season and is grown along with it by many growers.

**Parsons Beauty.**—Resembles Gibson.

**Senator Dunlap** (per).—Fruit conical, necked; below medium to small size; most of the fruit is gathered in a few pickings; soft; rich red; fine grained; high quality; cans well. Not highly productive. Very prolific plant maker. Plants small. Thrives better under neglect than most other varieties. Ripens early midseason, beginning just a few days after Premier. Grown less than formerly.

**Dr. Burrill.**—Resembles Senator Dunlap.

**Wm. Belt** (per.).—Fruit irregular, wedge conic; medium to large; soft; fine grained; good quality. Stalks long, stiff. Only moderately productive. Prolific plant maker. Very susceptible to leaf spot. Ripens midseason. Valued for home use and as a local market berry.

**Glen Mary** (semi-per.).—Fruit roundish to wedge conical; medium to large; appearance only fair, berries often with light colored tip; fair quality. Productive, but unreliable. Early blossoms hardly produce enough pollen to fertilize themselves. Moderately prolific plant maker. Apparently well liked by some growers but not a very desirable variety.

**Stevens Late** (per. to semi-per.).—Productive but not reliable. Fairly acid. Moderately prolific plant maker. Grown to some extent for late midseason.

**Haverland** (imp.).—Fruit long pointed, roundish to wedge conical; medium size; pale color detracts from appearance; rather coarse grained; fairly good quality. Moderately productive. Fair plant maker. Ripens early midseason. Not as extensively grown as formerly.

**Aroma** (per.).—Exceptionally good shipper. Productiveness, color, appearance, and quality only fair. Prolific plant maker. Leading variety in the large strawberry region of central southern states. Does not seem well adapted to Ohio, altho on the heavier soils it is sometimes grown as a late midseason variety.

**Gandy** (per. to semi-per.).—Fruit regular; medium size; firm; rather coarse grained; good quality. Not highly productive. Ripens late. Does best on heavier soils.

**Chesapeake** (per.).—Fruit roundish conic; medium to large; showy; high quality. Makes few runners and requires close planting for a good row of plants. Not highly productive. Ripens late midseason. Requires careful culture and perhaps does best only under irrigation.

**Brandywine** (per.).—Fruit broadly conic; medium to large; firm; dark colored; good quality. Only fair plant maker. Ripens midseason to late. An old variety not now extensively grown, but might be worth trial by growers who give it good care on fertile soils.

**Cooper** (per.).—Fruit soft, whitish at core; mild, sweet. Not highly productive. Only fair plant maker. When well grown fruit is large, but under most conditions decreases rapidly in size after first picking. Disappointing commercially.

**Beacon** (per.), **Boquet** (per.), and **Bliss** (per.).—Three recent introductions from the New York Experiment Station. Ripen in the order named. Beacon has attractive fruit, almost as if varnished, but has been disappointing in flavor. Boquet has been of average merit at Wooster and is well thought of by superintendents at some of the county experiment farm in Ohio. Fruit somewhat rough, bluntly wedge or conic; often with light colored tips; firm; well colored to the center; fairly good quality. Moderately productive. Fair plant maker. Bliss has been medium sized, handsome, well colored, and of fairly good quality in the Station plantings. Slightly less productive than Boquet.

### FALL BEARING

**Mastodon** (per.).—Produces crops in spring and thruout the fall months. Superior to Progressive, Champion, and other fall bearing varieties under test, as a plant maker, in health and appearance of plants, in yielding ability, and in size of fruit. Fruit not as uniform in size as desired, altho large when well formed; firm; fairly god quality. Rather subject to leaf spot. Of questionable value for commercial fruiting.

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